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(54) Antenna

(57) The invention comprises an antenna structure particularly suitable for mobile stations operating on two frequency ranges. As a supporting component and also as component determining the electrical characteristics the antenna includes a dielectric plate (21). On one surface of the dielectric plate there is a radiating element (22) with a meander form, and on the opposite support of the dielectric plate there is a planar radiating element (23). The operation on two frequency ranges is based on the fact that the structure has two resonance frequencies, which are relatively far from each other. The

strips are further relatively wide, due to which the antenna operates satisfactorily in different positions and in the vicinity of objects. The parasitic element can further have a gap operating as a separate radiator, whereby the antenna operates on three frequency ranges. The antenna according to the invention is flat, and therefore it can be fixed to the back wall of a mobile station, and the distance to the user's head is as large as possible.

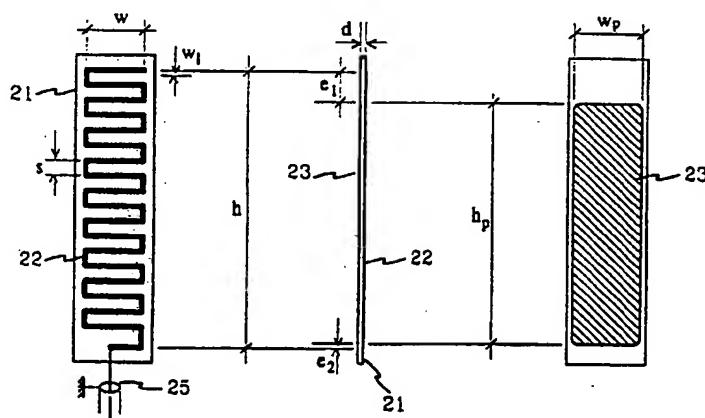


Fig. 2

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Figure 4 shows an antenna mounted in a mobile station in different situations;

Figure 5 shows some variations of the antenna according to the invention; and

Figure 6 shows a mobile communication means according to the invention.

[0009] The structures of figure 1 were already described above in connection with the description of prior art. In figure 2 there is a structure according to the invention, which includes a dielectric plate 21, a radiating element 22 connected to the feed line 25 of the antenna, and a radiating parasitic element 23. In this example the dielectric plate is the dielectric layer of the printed circuit board. The element 22 is a rectangular conductor pattern of the meander type, which is formed on the other side of the plate 21, for instance by etching. In this connection meander means a line without branches and where a certain basic form or its modification, or different basic forms, are repeated in sequence in the same direction. Examples of the meander pattern are shown in figure 5. Below the element 22 is called a meander element. A parasitic element means a conductor which is galvanically isolated from the other conductors of the system, but which has an electromagnetic coupling to them. In this example a parasitic element 23 is a conductor area formed by etching on the surface, which is opposite regarding the meander element, and which is electromagnetically coupled to the meander element. The symbols affecting the characteristics of the antenna are also marked in figure 2: the thickness d of the dielectric layer, the height h of the meander element 22, the width w of the meander element, the height s of the repeating pattern in the meander element, the width w_1 of the conductor of the meander element, the height h_p of the parasitic element 23, the width w_p of the parasitic element, the height difference e_1+e_2 of the meander and parasitic elements, of which e_1 is at the upper end of the structure and e_2 at the bottom end. The height direction means here and particularly in the claims the direction of the largest dimension h of the meander element.

[0010] The structure of the figure 2 has two resonance frequencies, of which the lower is determined mainly by the meander element 22, and the upper mainly by the parasitic element 23. Naturally the elements interact and thus have an effect on both resonance frequencies. The structure is characterised in that the resonance frequencies are relatively far from each other; one can be arranged for instance in the frequency range used by the GSM network, and the other in the frequency range used by a PCN network or satellite telephones. The structure is particularly characterised in that the bandwidths both in the upper and the lower operating range are relatively large. The planar parasitic element causes namely a wide upper band and also acts on the lower

band in a way which makes it wider. The bandwidths can be tuned by the dimensioning. When for instance the upper band is desired to be as wide as possible, then the parasitic element must be dimensioned as a wide one, and it must be located downwards, so that the dimension e_1 is relatively large. Wider bandwidths can also be obtained, without changing the resonance frequencies, by making the meander pattern with wider spaces, or by increasing the dimension s , and by at the same time increasing the heights h and h_p of the radiating elements. Thus there must be a compromise between the bandwidths and the antenna size. The characteristics of the antenna are affected by the antenna dimensions and also by the matter between the meander and the parasitic elements: when the dielectric constant of the dielectric plate increases the upper resonance frequency decreases.

[0011] The band characteristics of an antenna are often examined by measuring its return loss A_r as a function of the frequency. The return loss means the ratio between the energy supplied to the antenna and the energy returning from it. It is the absolute value of the inverse of the square of the reflection coefficient or the parameter S_{11} . The higher the return loss the larger part of the energy supplied to the antenna will be radiated into the environment, or the better the antenna operates. In an ideal case the return loss is thus infinite. When the return loss is 1, or 0 dB, the antenna will not radiate at all; all energy fed into it will return to the feeding source. The reception characteristics of the antenna follow the transmission characteristics: the more effectively the antenna transmits on a certain frequency and into a certain direction, the more effectively it also will receive on said frequency from said direction. The bandwidth of the antenna can be defined in different ways: it can mean the difference between those frequencies at which the return loss has decreased 3 dB from its best value or maximum value. Often the bandwidth is regarded as the difference between those frequencies at which the value of the return loss is 10 dB or 10. This corresponds to the value 2 of the standing wave ratio SWR.

[0012] Figure 3 shows an example of the variation of the return loss A_r of an antenna according to the invention as a function of the frequency in different operating situations. The measurements results have been obtained with the following dimensions of the antenna: $h = 29.3$ mm; $w = 5.4$ mm; $h_p = 24.4$ mm; $w_p = 5.4$ mm; $e_1 = 4.2$ mm; $e_2 = 0$ mm; $s = 1.6$ mm; $w_1 = 0.5$ mm; and $d = 0.76$ mm. The dielectric constant of the printed circuit board is $\epsilon_r = 2.5$. The measurement range in figure 3 is from 800 MHz to 2.2 GHz. The thin unbroken curve 31 corresponds to the situation of figure 4a: the antenna is out and pointing upwards, and there are no other objects in the vicinity. The broad unbroken curve 32 corresponds to the situation of figure 4b: a human head is now adjacent to the mobile station. The dotted line 33 corresponds to the situation of figure 4c: the antenna is

- the supporting structure for the meander and parasitic elements (22, 23) is a dielectric plate (21).

2. A structure according to claim 1, characterised in that the width (w) of the meander element in a first point in the height direction is different from its width in a second point in the height direction. 5

3. A structure according to claim 1, characterised in that the height (h_p) of the parasitic element (23) is less than the height (h) of the meander element (22). 10

4. A structure according to claim 1, characterised in that the width (w_p) of the parasitic element (23) in a first point in the height direction is different from the width in a second point in the height direction. 15

5. A structure according to claim 1, characterised in that the dielectric plate (21) is the dielectric part of a printed circuit board. 20

6. A structure according to claim 5, characterised in that the meander element (22) is a conductor area on the first surface of said printed circuit board and that the parasitic element (23) is a conductor area on the second, opposite surface of said printed circuit board. 25

7. A structure according to claim 1, characterised in that the parasitic element (23) has a radiating gap (51). 30

8. A structure according to claim 1 which comprises a first parasitic element and a second parasitic element (52), characterised in that said second parasitic element (52) is conductor area on the same side of the dielectric plate as the meander element. 35

9. A mobile station having an antenna structure which comprises a feed line, a first element (22) connected to the feed line and at least one parasitic element (23), characterised in that 40

- the first element (22) is a meander element,
- the parasitic element (23) is a planar conductor area, and

in that the antenna structure further comprises a supporting structure (21) for the meander and parasitic elements, which supporting structure is a dielectric plate. 50

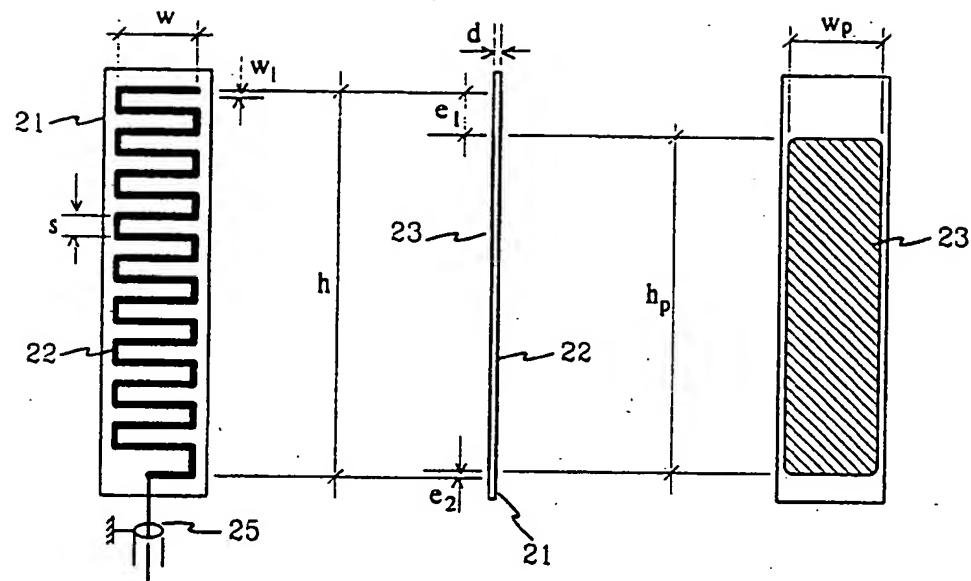


Fig. 2

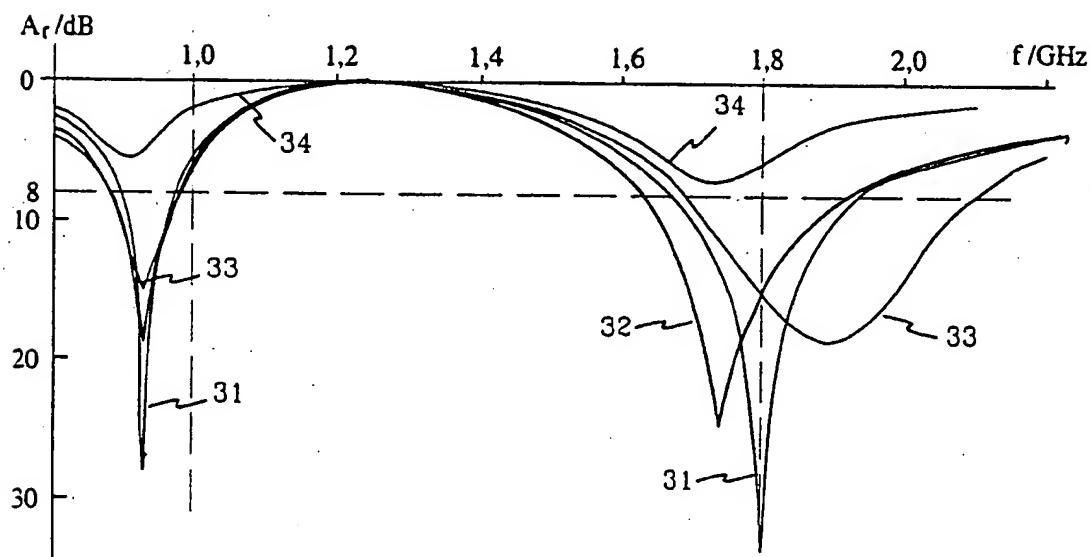


Fig. 3

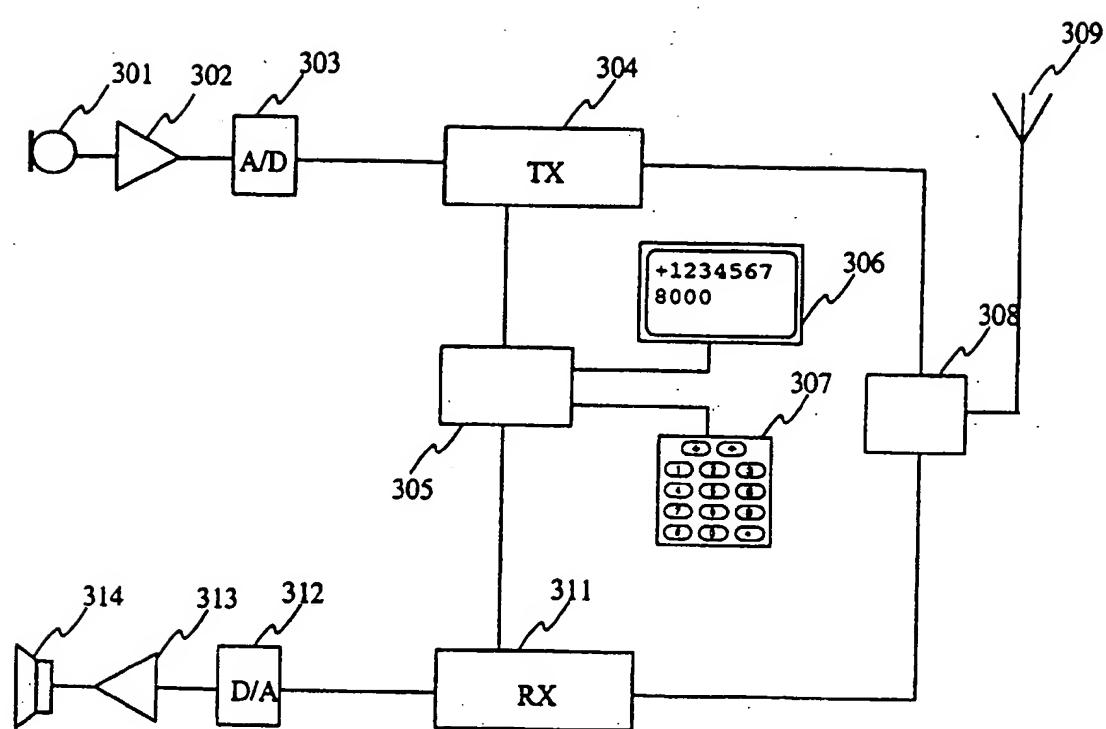


Fig. 6



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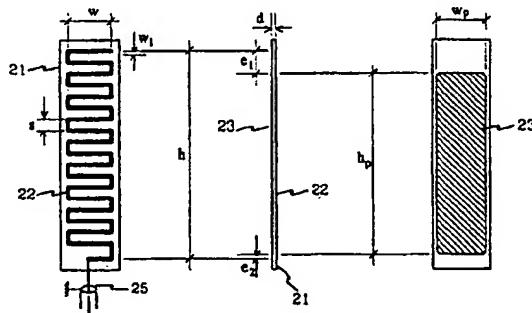


Fig. 2

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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